RP 201 Generator Collector Ring Assembly Maintenance

The following recommended practice (RP) is subject to the disclaimer at the front of this manual. It is important that users read the disclaimer before considering adoption of any portion of this recommended practice.

This recommended practice was prepared by a committee of the AWEA Operations and Maintenance Working Group.

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Purpose and Scope

The scope for “Generator Collector Ring Assembly Maintenance” addresses the common maintenance issues related to the collector ring assembly in double fed induction generators that are commonly used in many wind turbine designs. This section is not machine specific and some variations may be required based on specific designs.

Introduction

In double fed induction generators, power is normally transferred to and from the wound rotor by the use of rotating collectors and brush assemblies. These are high wear items and should be included in any regularly scheduled maintenance inspection or process. The normal recommendation is to inspect and clean at least bi-annually, but longer maintenance cycles may be possible with improved materials and designs. Brush life is affected by carbon grade, ambient temperature, and humidity, as well as other operating environmental conditions. It is critical to the successful implementation of these procedures that good records are kept of generator maintenance and of any performance issues discovered between inspection intervals. Prior to any disassembly at each step, a careful visual inspection should be performed and any abnormal conditions should be documented, preferably including photographs.

Collector Ring Assembly Maintenance Procedures

1. Inspecting the Assembly

Remove the generator collector ring cover(s). View the general condition of the assembly. Note any build up of residue, leaking gaskets, broken or missing components, etc. A 1000 volt phase-to-phase and phase-to-ground insulation resistance test of the collector ring assembly is also suggested before and after cleaning. Caution should be used to ensure the test voltage will not damage any electronic components. Review OEM motor testing procedures. Values should conform to the generator manufacturer's specifications, but normally the minimum value should exceed 10 megaohms during service and 100 megaohms after cleaning. Leads should be disconnected before testing.

1.1. Brushes

1.1.1. Removal

To remove the brush for most designs, push forward on the spring to disengage the latch and lift the spring out of its slide. Other styles of tension devices may be used. Consult the manufacturer's specifications for a specific generator design. Pull the brush out of its holder by its cables without disconnecting it. Note the orientation of the brush to the holder to ensure the brush will properly be reinstalled if it is not to be replaced.

1.1.2. Brush Body

Inspect the brush for minimum length requirement and any unusual wear-marks and free movement of the brush in the holder noting any restriction that may be a sign of material swelling.

NOTE: This should also be a regular test for lightning protection brushes and grounding brushes.

Inspect for chipping or cracking. Assure that the terminals are secure and that shunts, micro switch tabs, etc. and rivet connection, if applicable, are in good working order and properly mounted and connected.

1.1.3. Stunt Wires

Discolored shunt wires can indicate uneven current sharing or overheating by insufficient air flow. It is recommended to replace the complete brush set because single brushes can already be damaged. If the shunts are damaged or frayed by vibration, mechanical problems, or too strong air flow, they should also be replaced and the condition corrected. Note any abnormal wear indicators. Verify terminal connections are secure on all brushes.

1.1.4. Vibration Markings

Smooth and shiny side surfaces are a clear indication of radial movement by the brushes in the brush box. This can be caused by out-of-roundness of the slip ring. Excessively high friction can also result in a shiny slip ring surface or external vibrations such as defective bearings, shafts, couplings, etc. Markings of current transfer between brush holders and brush indicate that the connection between shunt and brush body is possibly damaged. Excessive brush dust in the slip ring compartment can also cause inappropriate current transfer. Frayed shunts or markings from the springs on the brush top also indicate abnormal vibration.

1.1.5. Brush Surface

Rough brush face surfaces may be caused by brush sparking from electrical or mechanical problems, e.g. vibrations. Rough surfaces on grounding brush faces can be an indication of possible converter problems as well as ring surface issues.

Rule of thumb: If one of the brushes has to be replaced and the set is worn more than 25%, all the brushes should be replaced. If all brushes are to be replaced, disconnect them, and remove them from the assembly. Loosen the terminal bolts until the brush terminal can be slid out from underneath. If possible, do not fully remove the bolt to avoid dropping it and other hardware into the assembly.

1.2. Brush Holder

1.2.1. Holder Box

Inspect entire holder for any indications of arcing or burning damage. Verify that all hardware and electrical connections are secure. Note any abnormal wear indicators.

1.2.2. Springs

Inspect tension devices for any indications of arcing, burning, or discoloration. The spring force should be checked every year with an appropriate spring scale device and springs should be replaced every 3 to 5 years depending on the type of application. Springs with a deviation of more than 10% from the set value should be replaced.

1.2.3. Holder Distance

For a safe guidance of the brushes in the brush holder, it is normally suggested that the distance between holder and slip ring surface is no more than 3 mm (0.125”).

1.3. Collector Rings

If possible, the collector ring surface should also be checked regularly for grooving and other damage. Consult OEM specifications for tolerances. The collector ring assembly and the surrounding area should be checked for oil contamination. If oil or grease from the bearing comes into contact with the slip ring surface, an insulating film can be formed which hampers the current transfer. Increased brush wear could be the consequence. The brushes are porous and, in the case of oil contamination, all brushes should be replaced after the collector ring is cleaned.

1.3.1. Excessive TIR (Total Indicator Runout or Out-of-Round)

All collector ring assemblies are installed with round rings. After a few years of service, the collector ring can deteriorate to a TIR greater then 0.010”. This out-of-roundness cannot be seen with the naked eye. Special profilers are required to accurately measure the out-of-roundness. The out-of-roundness develops in many forms such as an oval shape, a shape with multiple lobes or a round shape that has many low spots. The textbook limit for out-of-roundness on a collector ring is 0.003”. The average wind collector ring has a 32 inch circumference.

1.3.1. Excessive TIR (Total Indicator Runout or Out-of-Round) (continued)

The suggested out-of-roundness of collector ring performance evaluation and profiling guideline is:

> Not to be more than 0.001 inch out-of-roundness per 1.000 inch of travel with a maximum of 0.015” total indicator runout.

If the above criteria is met and there are no signs of brush burning and ring erosion, the collector ring be can returned to operation.

1.3.2. Grooving

Vibration and the environment can cause collector rings to wear or groove after extended periods of operation. The proper brush grade and brush springs can significantly reduce the amount of slip ring wear. The generator can be operated with a groove ring as long as the TIR is not too high and the brush remains in contact with the slip ring. A spiral groove is often machined into the collector ring. If the collector ring is worn past the spiral groove, the collector ring should be replaced.

1.3.3. Generator Shaft

The profiler mentioned in 1.3.1. can also be used to measure the shaft runout. With the slip ring removed, measure the shaft indicated runout as it turns. It is not uncommon to find that the shaft is bent. If the shaft variation exceeds 0.006 inch, you should consider contacting a skilled technician or service provider for further evaluation and correction.

1.3.4. Signs of Brush Sparking

Extreme brush sparking may cause a serious flash over. Signs of sparking can be found on the brushes, the brush boxes, the rocker rings, or other paths nearby the slip ring.

1.3.5. Brush Dust

Carbon brush dust is a good conductor. Excessive accumulation of dust, therefore, may also create flash over and must be removed regularly during the inspection. Sufficient air flow is essential for successful removal of brush dust. Filters, air tubes, etc., should therefore also be checked regularly. The complete ventilation system should be cleaned and checked for proper operation.

2. Cleaning and Reassembly

2.1. Cleaning Collector Ring Assemblies

The collector ring assembly cover(s) should be completely removed and all components inspected as above before proceeding with cleaning. For these cleaning procedures, it is suggested that appropriate personal protection devices be worn, including a dust mask.

Use a small vacuum, preferably with a HEPA type filtration system, and a non-metallic brush to remove all accumulated dust and other contaminants from the collector ring enclosure, the brush holder assemblies, any supporting rods or fixtures, and the collector ring itself. Contact cleaner or other solvents should not be used directly on the collector ring as they may drive the carbon dust deeper into the insulated area reducing the dielectric properties of the assembly. If it is necessary to use a solvent, spray the solvent on a disposable towel or cloth and use the cloth to wipe the solvent on the unclean area. Do not use solvents on carbon brushes because they could affect the carbon material. The collector ring film, or patina, should not be cleaned with a solvent. If the collector ring surface does require cleaning, only use a mild abrasive tool such as a non-conductive abrasive pad or a flexible rubber abrasive. Always clean from the top down to avoid re-contaminating components.

NOTE: If a brush is not to be replaced, it should remain connected during inspection and cleaning to assure the return to its original location.

2.2. Installing Brushes

To install new brushes or to reinstall brushes after inspection, insert the brush into the holder ensuring the proper orientation, then slide the spring clip back into its slot and push it down onto the brush until the spring clip latch clips into the retaining notch. Connect new brushes and check that the connection is tight and the terminal is located correctly under the spring washer. As a final check to assure that the brush is free to move up and down in the brush holder and that the spring clip latch is correctly fitted, pull on the brush leads and lift the brush approximately 12 mm (0.5”) and then lower it back onto the slip ring a few times.

2.3. Seating New Brushes

Many new brushes are manufactured with a bottom radius. This radius is not the exact contour of the slip due to manufacturing tolerance, brush holder orientation, and slip ring wear. In order to ensure adequate electrical contact to the collector ring, the brushes must be properly seated. Poor contact at startup can lead to major performance issues, shortened brush life, and even component damage.

Garnet paper or any non-metal bearing abrasive paper is recommended and cloth backed abrasives are often easier to use in many circumstances. The abrasive size should be 80 to 120 grit. Fine sandpaper, such as 400 grit, will easily fill with carbon making the sanding process more difficult. It is important not to leave abrasive particles under the brushes when completed as these could damage the slip ring surface.

Seat one brush at a time while all the other brushes are still connected but out of their holders.

Lift the brush by its shunts and slide a strip of the abrasive cloth under it with the abrasive side of the paper facing the brush. Lower the brush down onto the abrasive cloth and place the spring in its normal engaged position. The spring should apply the pressure to the brush. Slide the garnet paper back and forth under the brush in line with the brush path. After several passes back and forth, remove the brush from its holder and check the face of the brush. The seating is complete when at least 80% of the brush face is abraded. Vacuum out all of the accumulated carbon dust and sanding debris and reinstall the brush and spring-clips. Repeat with all new brushes or with used brushes with improper seating marks.

2.3. Seating New Brushes
(continued)

Once properly assembled, assure that all bolts are tightened and the brushes are properly connected.

Again, as a final check that the brush is free to move up and down in the brush holder and that the spring clip latch is correctly fitted, pull on the brush leads and lift the brush approximately 12 mm (0.500”) and then lower it back onto the slip ring a few times.

Also, make sure that all tools and cleaning materials are removed from the area and the cover gaskets are functioning properly before replacing the cover.